

PHYTOGEOGRAPHIC AND BIOTIC RELATIONSHIPS OF A SAVANNA IN SOUTHERN AFRICA: ANALYSIS OF AN ANGIOSPERM CHECK-LIST FROM ACACIA WOODLAND IN ZULULAND

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ABSTRACT

Floristic analysis of a list of 425 species revealed some ecological features of a semi-arid woodland or savanna represented in the Umfolozi Game Reserve, which is dominated by *Acacia* species and graminoid forms. A poor representation of forbs was ascribed to foraging and trampling by indigenous herbivores. An exceptionally low presence of species of Orchidaceae and Asclepiadaceae was apparently due in part to elimination of their insect pollinators when DDT was applied to control tse-tse flies some 30 years ago. The Reserve is evidently close to the southernmost limit of *Acacia* Woodland of the Zambezi Domain. The Reserve contains many species of Tiliaceae and Ebenaceae characteristic of the Tongaland-Pondoland Regional Mosaic, but few species are present from other phytochoria in the Indian Ocean Coastal Belt.

UITTREKSEL

FITOGEOGRAFIESE EN BIOTIESE VERHOUDINGS VAN 'N SAVANNA IN SUIDELIKE AFRIKA: ANALISE VAN 'N ANGIOSPERM KONTROLELYS VAN 'N ACACIA-BOSLAND IN ZOELOELAND

'n Floristiese analise van 425 spesies onthul 'n paar ekologiese kenmerke van 'n semi-droë bosland of savanna, wat deur *Acacia* spesies en grasagtige plante gedomineer word. Kruide was swak verteenwoordig en dit word toegeskryf aan beweiding en uittrapping deur inheemse plantvreters. 'n Besondere lae persentasie spesies van die Orchidaceae en Asclepiadaceae kan gedeeltelik toegeskryf word aan die eliminatie van hul insekbestuiers toe DDT aangewend is om tsetsevlies te beheer. Die Reservaat kom voor as 'n unieke, mees suidelike grens van *Acacia*-bosland wat tipies is van die Zambesie Gebied. Die Reservaat bevat baie soorte Tiliaceae en Ebenaceae wat kenmerkend is van die Tongaland-Pondoland streks-mosaïek, maar min verteenwoordigers uit ander gebiede van die Indiëroseaan kus-streek word ontdek.

INTRODUCTION

The Umfolozi Game Reserve was selected for this phytogeographic study because its area of 500 km² contains the most extensive, diverse and well-preserved representative of semi-arid savanna found on the eastern seaboard of South Africa. The Reserve was proclaimed in 1897 in order to protect wildlife in

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Accepted for publication 13th April, 1981.

the vicinity of the confluence of the Black and White Mfolozi Rivers, which lies near latitude S 28° 20', longitude E 31° 50', at a point 50 km west of where Lake St Lucia opens to the Indian Ocean. Proclaimed in 1897, the Umfolozi is one of the early nature reserves established in Africa. Vegetation in the Reserve is in a good state of preservation compared with similar areas of savanna used by farmers.

The Reserve is markedly different from immediately adjacent areas in both climate and vegetation. The Reserve itself is hot and dry, as reflected by a mean annual temperature of 23 °C and a mean annual rainfall of 635 mm. These semi-arid conditions arise because the Reserve lies within the valleys of the Black and White Mfolozi Rivers which are deeply incised.

The valleys differ from the cooler and more humid climate of adjacent highlands to the north and west. The highland vegetation is grassland and forest of a more temperate nature, and contrasts with an obviously xerophytic, largely spinescent and deciduous *Acacia* Woodland in the dry valleys of the Reserve. There is another sharp contrast with yet a third bioclimatic region to the east of the Reserve. Some 20 km east of the confluence, the Mfolozi River enters the hot and humid Zululand Coast Plain which has tropical evergreen vegetation.

A main purpose of this study is to record the angiosperm species in the Reserve, an important objective in view of the rapid deterioration of other areas of *Acacia* habitat. Although valleys geomorphologically similar to the Mfolozi exist to the south (for example the Tugela and the Mkomazi) the vegetation of these areas has been radically altered by human activity. The study also attempts an explanation of some interesting phytogeographical aspects of vegetation in the Reserve which provides food or shelter for some 18 species of large herbivores. Names and biomasses of these animals are available from Mentis (1970).

METHOD

The basic list of species was compiled from plant collections made by Downing during the course of a detailed plant ecological study (Downing, 1972). Sets of specimens are housed at herbaria in Hluhluwe Game Reserve, the University of Natal in Pietermaritzburg (NU) and at the Botanical Research Institute in Pretoria (PRE).

RESULTS

A total of 425 species or subspecific taxa are listed for the Reserve in the Appendix. These species are distributed into higher taxa as shown in Table 1. All families with five or more species (more than one percent of the total number of species) are listed in Table 2.

Comparison between the largest families in the Reserve with the largest families from other areas in southern Africa show some interesting differences.

TABLE 1.
Numbers of taxa represented in the check-list of angiosperms of the Umfolozi Game Reserve.

	Monocotyledonae		Dicotyledonae		Total
	No.	% of total	No.	% of total	
Families	10	11,7	76	88,4	86
Genera	77	30,1	179	69,9	256
Species	154	36,2	271	63,8	425

TABLE 2.
Families with more than 1 % of the total number of species.

Family	No. species	% of total no. of spp. (425)	No. genera	% of total no. of genera (256)
1. Gramineae	103	24,3	49	19,2
2. Leguminosae	30	7,0	15	5,9
3. Compositae	28	6,6	18	7,1
4. Cyperaceae	23	5,4	7	2,7
5. Acanthaceae	16	3,8	11	4,3
6. Liliaceae	15	3,5	10	3,9
7. Euphorbiaceae	12	2,8	9	3,5
8. Rubiaceae	11	2,6	7	2,7
9. Tiliaceae	10	2,4	1	0,4
10. Ebenaceae	9	2,1	2	0,8
11. Anacardiaceae	7	1,7	3	1,2
12. Moraceae	7	1,7	1	0,4
13. Malvaceae	6	1,4	5	2,0
14. Boraginaceae	6	1,4	4	1,6
15. Capparaceae	6	1,4	4	1,6
16. Celastraceae	6	1,4	2	0,8
17. Amaranthaceae	5	1,2	5	2,0
18. Labiatae	5	1,2	5	2,0
19. Vitaceae	5	1,2	3	1,2
20. Sterculiaceae	5	1,2	3	1,2

Generally, the major components of the floras of all these areas are much the same even though the sizes of the areas vary considerably both in extent and in number of species, as shown in Table 3. Note that in all lists the Leguminosae, Compositae and Gramineae are in the positions of the three largest families. Furthermore, all five lists have the families Rubiaceae, Cyperaceae and Liliaceae; four of the lists have Euphorbiaceae and Asclepiadaceae; three of the lists have Acanthaceae; two of the lists have Scrophulariaceae and Labiatae.

TABLE 3.

The number of species contained by the 10 largest families in the Umfolozi Game Reserve compared with the 10 largest families in four other areas. Data for Suikerbosrand Nature Reserve from Bredenkamp and Lamprechts (1979), and from Gibbs Russell (1975) for the remainder.

Umfolozi G.R.		Suikerbosrand N.R.		Natal		Swaziland		Rhodesia	
Gramineae	103	Gramineae	115	Compositae	546	Compositae	260	Leguminosae	610
Leguminosae	30	Compositae	110	Leguminosae	420	Leguminosae	220	Gramineae	563
Compositae	28	Leguminosae	56	Gramineae	410	Gramineae	173	Compositae	372
Cyperaceae	23	Liliaceae	31	Liliaceae	226	Liliaceae	137	Orchidaceae	353
Acanthaceae	16	Cyperaceae	28	Asclepiadaceae	207	Asclepiadaceae	104	Cyperaceae	224
Liliaceae	15	Scrophulariaceae	22	Orchidaceae	206	Labiatae	103	Euphorbiaceae	192
Euphorbiaceae	12	Asclepiadaceae	21	Cyperaceae	168	Euphorbiaceae	84	Rubiaceae	177
Rubiaceae	11	Rubiaceae	20	Euphorbiaceae	146	Orchidaceae	82	Asclepiadaceae	163
Tiliaceae	10	Acanthaceae	17	Rubiaceae	130	Cyperaceae	76	Liliaceae	159
Ebenaceae	9	Labiatae	15	Scrophulariaceae	127	Rubiaceae	70	Acanthaceae	158
No. spp. in 10 largest families		431		2 586		1 309		2 971	
Total no. spp. in flora . . .		742		4 818		2 307		5 204	
% of total no. spp. in 10 largest families . . .		58		54		57		57	
Area covered (km ²) . . .		133		86 967		17 363		390 750	

Only one of the lists, that of the Umfolozi Game Reserve, has families ranked among the ten largest that occur only on that one list. These are the families Tiliaceae and Ebenaceae. Conversely, only in the flora of the Reserve are the Orchidaceae and Asclepiadaceae missing from the list of largest families. (In the Suikerbosrand Nature Reserve, the Orchidaceae is in 12th position in number of species.)

DISCUSSION

Biotic and climatic factors may explain the near absence of members of Orchidaceae from the Reserve, even though they are important in the floras of adjacent regions. Ground orchids are unknown in the Reserve, even though species occur in other dry areas. It is suggested that several biotic factors may have caused their elimination from the Reserve by reducing both their asexual and sexual means of propagation.

Game animals such as warthog, wild pig, porcupine, baboon and antelopes, which feed on the underground storage organs of plants, are present in the Reserve in heavy concentrations. During the winter months when succulent herbage is very scarce they could have severely depleted the rhizomes of any ground orchids present, thus impairing their asexual propagation. At the same time, sexual reproduction could have been inhibited by elimination of insect pollinators as a result of the extensive and intensive spraying of insecticides (DDT and BHC) during the anti-nagana or tse-tse fly campaign in the Reserve from 1947 to 1951 (see Vincent, 1970). Orchids would be especially sensitive to such a loss of pollinators because of the close co-evolution of orchid and hymenopteran species.

The lack of epiphytic orchids is probably also a response to the insecticides as well as to climatic conditions. The greatest concentration of epiphytic orchids in South Africa is in Zululand, mainly in the magisterial districts of Eshowe, Hlabisa and Ingwavuma (Harrison, 1972). These districts are for the greater part much more humid than the arid Reserve which they virtually surround. Thus, dry atmospheric conditions in the Reserve may have precluded a high representation of epiphytic orchids. The only species recorded, *Ansellia gigantea*, is well known from dry areas. The species appears to be represented in the Reserve by a single colony of great age, and no young specimens were found. This suggests that reproduction has been adversely affected in the epiphytic orchids. Surprisingly, the small orchid *Microcoelia exilis* has not been recorded for the Reserve even though it is an abundant epiphyte on some *Acacia* thickets in the Hluhluwe, Mkuze, and St Lucia Reserves.

The paucity of Asclepiadaceae might also be a result of elimination of pollinating insects, damage by herbivores and damage from periodic veld fires.

Furthermore, both Orchidaceae and Asclepiadaceae are mostly herbaceous families and their paucity is part of an overall scarcity of forbs in the Reserve.

This scarcity is probably due to a selective-grazing habit of the herbivores, detailed by Downing (1974, 1979), whereby some areas are grazed lightly whilst others are heavily grazed and trampled. A typical, lightly grazed stand could have an 800 mm tall layer of grasses with a canopy cover of 60 %. Competition from so dense a stand of tall grasses is such that the cover of short forbs is confined to one or two percent. The forbs are mostly of a woody nature and are fire sensitive. Fires, which easily burn through such stands after drying of the grasses in winter, also suppress the forb growth. However, in over-grazed areas the grasses are reduced to a height of 200 mm and a canopy cover of 15 % or less; the passage of fire is not possible in such conditions in the Reserve and forb cover increases to 25 %. Although forb density is relatively high in these over-grazed areas, the plants represent only a few, prolific species. These are often annuals from the families Compositae and Acanthaceae, the latter being rather well represented in the Reserve (see Table 3). The annuals survive intensive trampling by animal hooves, induration of the bare soil surface by exposure to insolation, and reduced soil-water infiltration consequent to overgrazing.

The two families which replace the Orchidaceae and Asclepiadaceae among the ten largest families in the Reserve are the Ebenaceae and Tiliaceae (Table 3). Ebenaceae is prominent in the flora because of the large number of species in the genera *Euclea* and *Diospyros*. White and Moll (1978) state that these two genera have their centres of distribution in the Tongaland-Pondoland Regional Mosaic of the Indian Ocean Coastal Belt. The Reserve contains nine members of the Ebenaceae and may thus be of some importance for evolutionary study of this family. Much the same could be said of the Tiliaceae which is represented by 10 species of *Grewia*.

TABLE 4.
Genera with more than 1 % of the total number of species.

Genus	No. spp.	% of total no. of species (425)
<i>Acacia</i>	14	3,3
<i>Cyperus</i>	10	2,4
<i>Grewia</i>	10	2,4
<i>Digitaria</i>	9	2,1
<i>Brachiaria</i>	8	1,9
<i>Sporobolus</i>	8	1,9
<i>Aristida</i>	7	1,7
<i>Eragrostis</i>	7	1,7
<i>Ficus</i>	7	1,7
<i>Euclea</i>	5	1,2
<i>Scirpus</i>	5	1,2

All of the 11 genera in the Reserve which have more than one percent of the total number of species (Table 4) are either woody or graminoid in habit. This reflects the physiognomic essence of vegetation structure in the Reserve, which is a 5 m tall layer of conspicuous trees imposed upon a grass layer. Occasionally, where shrubs are dense, they may form a distinct stratum. The two largest genera show specific adaptations to the seasonally arid conditions. *Acacia* in the Reserve has finely divided deciduous leaves which are supposed to fold during unseasonal drought and which are shed during the regular, winter droughts. *Cyperus* often has hard underground storage organs and, like all other plants of graminoid habit in the Reserve, undergoes die-back of the aerial portions during the dry winter months.

That the Reserve may be near the southern limit of *Acacia* Woodlands is indicated because a number of species in the largest woody genera (Table 4) are at or near the limits of their distribution. For the 14 species of *Acacia* in the Reserve, Ross (1971) shows that the Reserve is at the southernmost limit for the distribution of four species (*Acacia borleae*, *A. grandicornuta*, *A. luederitzii* var. *retinens*, and *A. nigrescens*), while another eight species are near the southern limit of their distribution. Furthermore, two species (*A. davyi* and *A. xanthophloea*) have a distribution which ends just north of the Reserve near Hluhluwe.

Some species of *Grewia*, *Ficus* and *Euclea* are shown in the maps of Coates Palgrave (1978) to also have their southern distribution limits near the Reserve. Of the 10 species of *Grewia* recorded in the Reserve, seven (*Grewia bicolor*, *G. caffra*, *G. flava*, *G. flavescens*, *G. hexamita*, *G. subspathulata* and *G. villosa*) are near the southern limits of their distribution. *Ficus* has four (*Ficus capreifolia*, *F. pretoriae*, *F. stuhlmannii* and *F. sycamorus*) of its seven species near the distribution limits. *Euclea* has five species recorded in the Reserve, of which two (*Euclea divinorum* and *E. undulata*) extend no farther to the south in Natal.

The area of the Reserve is included by White & Moll (1978) as part of their Tongaland-Pondoland Regional Mosaic in the Indian Ocean Belt. However, the Reserve might be more closely related to the Zambezian Region than to any other region of the Indian Ocean Belt. Of the 15 endemic genera listed by White & Moll for the Tongaland-Pondoland Regional Mosaic, only two, *Hippobromus* and *Galpinia*, occur in the Reserve. A link between the Tongaland-Pondoland Mosaic and the Reserve is the large number of species of Ebenaceae; but both *Euclea* and *Diospyros* are widespread genera with many species in Zimbabwe and Botswana, which both lie in the Zambezian Region.

Relationships between the flora of the Reserve and other major phytochoria of Southern Africa are summarized in Table 5. Some fairly strong affinities are shown between the Reserve and the Zambezian Region, and to a lesser extent the Karoo-Namib Region; but there is little similarity to other phytochoria. Physiognomically the vegetation of the Indian Ocean Coastal Belt is typically forest whereas the Zambezian Domain is typically savanna or woodland (Werger,

TABLE 5.

Total number of species, quoted by White & Moll (1978) as linking the Tongaland-Pondoland with other phytochoria, as compared with the numbers of these species recorded in Umfolozi Game Reserve.

Phytochorion	No. of linking species quoted by White & Moll (1978)	No. of these species occurring in the Reserve
Zambezian	26	5
Afromontane	5	0
"Upland"	14	0
Cape/Afromontane	8	0
Karoo-Namib	12	3
Guineo-Congolian	9	1

1978). In this regard also the Reserve appears to have closer affinities with the Zambezian Region.

CONCLUSIONS

The flora of the Reserve is regarded as a discrete section of the Tongaland-Pondoland Regional Mosaic that is characterised by strong Zambezian affinities, but which has few affinities with adjacent phytochoria, including the northern region of the Indian Ocean Coastal Belt. This lack of floristic similarity with surrounding, comparatively humid areas (whether of highland or coast plain) is expected in view of the marked physiographic and climatic differences between the deeply incised Mfolozi valley and contiguous areas.

The Reserve is situated close to the distribution limit of many *Acacia* species and could be regarded as the southernmost extension of the *Acacia* Woodlands or Savannas typical of parts of central and east Africa. Nowhere south of the Reserve is found such a diversification and dominance by *Acacia* species.

The possibility of Orchidaceae and Asclepiadaceae having being reduced through elimination of insect pollinators cannot easily be confirmed because no check-list of the flora was available prior to the present, and very few or no botanical records were made for the Reserve prior to the aerial spraying of insecticides starting in 1948. Reference to proximal, geographically similar areas might help resolve the problem even though being of farmland or of conserved areas similarly treated with insecticides. Rather similar floral types to Umfolozi are in lowlands to the north, e.g. near Hluhluwe and Mkuze, but these appear less comprehensive and are extensively disturbed by human activity.

In spite of the use of insecticides and of other interference, the extent of the Reserve warrants conservation because its vegetation appears to be the last,

reasonably intact and comprehensive representative of what is probably a unique floral type close to the southernmost limit of its distribution in south-east Africa.

ACKNOWLEDGEMENTS

The authors thank the Natal Parks, Game and Fish Preservation Board for funding this work. We acknowledge the identifications kindly provided by Professor Kathleen Gordon-Gray and Dr Olive Hilliard at the University of Natal, as well as by staff of the Botanical Research Institute, Pretoria. Messrs. O. Bourquin, I. A. Macdonald and A. Whateley confirmed some distribution records.

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APPENDIX: SYSTEMATIC LIST

Angiosperm families and genera appear in the order used in *The Flora of Natal* (Ross, 1972). Species are listed alphabetically within genera. Aquatic plants and exotics are excluded. Additional species records are most likely to be obtained near rock outcrops and stream banks. The majority of species listed can be

found in many of ten woody plant communities mapped and floristically described in detail by Downing (1972). The major differences between these communities lay in differences, sometimes of only minor magnitude, in the relative abundance of species present. Provision of detailed habitat data in the check-list thus seems of little value. However, a notation in the margin by the letters O (for Open Woodland), C (for Closed Woodland) or R (for Riverine Woodland) is given only for those species with a conspicuous preference for a particular woodland association. The collection numbers of Downing are cited in the list. Absence of a number indicates that the record was obtained from a specimen in some other collection at the Hlululuwe Herbarium.

GRAMINEAE

<i>Imperata cylindrica</i> (L.) Beauv. var. <i>major</i> (Nees) C. E. Hubb.	583 R
<i>Ischaemum arcuatum</i> (Nees) Stapf	542 R
<i>Hemarthria altissima</i> Stapf & C. E. Hubb.	540 R
<i>Trachypogon spicatus</i> (L.f.) Kuntze	
<i>Elyonurus argenteus</i> Nees	438
<i>Andropogon appendiculatus</i> Nees	
<i>Sorghum halepense</i> (L.) Pers.	470 R
<i>Bothriochloa insculpta</i> (Hochst.) A. Camus	565
<i>Cymbopogon excavatus</i> (Hochst.) Stapf ex Burtt Davy	
<i>Cymbopogon marginatus</i> (Steud.) Stapf ex Burtt Davy	567
<i>Cymbopogon plurinodis</i> (Stapf) Stapf ex Burtt Davy	580
<i>Cymbopogon validus</i> Stapf ex Burtt Davy	
<i>Hyparrhenia filipendula</i> (Hochst.) Stapf var. <i>pilosa</i> (Hack.) Stapf	566
<i>Hyparrhenia hirta</i> (L.) Stapf	578
<i>Heteropogon contortus</i> (L.) Beauv. ex Roem. & Schult.	477
<i>Diheteropogon amplexans</i> (Nees) W. D. Clayton	526
<i>Hyperthelia dissoluta</i> (Nees ex Steud.) W. D. Clayton	571 O
<i>Themeda triandra</i> Forsk. var. <i>trachyspatha</i> Goosens	428 O
<i>Tragus berteronianus</i> Schult.	444 C
<i>Perotis patens</i> Gand.	445
<i>Paspalum commersonii</i> Lam.	626 R
<i>Paspalum distichum</i> L.	627 R
<i>Paspalidium</i> sp.	
<i>Eriochloa borumensis</i> Stapf	
<i>Panicum coloratum</i> L.	C
<i>Panicum deustum</i> Thunb.	425 C
<i>Panicum maximum</i> Jacq.	471 C
<i>Panicum meyerianum</i> Nees var. <i>grandeglume</i> Stent & Rattray	615 R
<i>Urochloa mosambicensis</i> (Hack.) Dandy	441 C
<i>Urochloa trichopus</i> (Hochst.) Stapf	524
<i>Brachiaria deflexa</i> (Schum.) C. E. Hubb. ex Robyns	468
<i>Brachiaria dictyoneura</i> (Fig. & de Not.) Stapf	525
<i>Brachiaria eruciformis</i> (Sibth. & Smith) Griseb.	520
<i>Brachiaria humicola</i> (Rendle) Schweick.	
<i>Brachiaria nigropedata</i> (Munro) Stapf	434
<i>Brachiaria ramosa</i> Stapf	
<i>Brachiaria serrata</i> (Spreng.) Stapf	
<i>Brachiaria xantholeuca</i> (Hack.) Stapf	
<i>Echinochloa colonum</i> (L.) Link.	581 R
<i>Echinochloa holubii</i> (Stapf) Stapf	R

<i>Sacciolepis curvata</i> (L.) Chase	
<i>Digitaria argyrograptia</i> (Nees) Stapf	521 C
<i>Digitaria debilis</i> (Desf.) Willd.	
<i>Digitaria eriantha</i> Steud.	
<i>Digitaria longiflora</i> (Retz.) Pers.	523
<i>Digitaria macroglossa</i> Henrard	501a
<i>Digitaria natalensis</i> Stent	
<i>Digitaria pentzii</i> Stent	
<i>Digitaria polevansii</i> Stent	519 C
<i>Digitaria smutsii</i> Stent	467 C
<i>Tricholaena monachne</i> (Trin.) Stapf & C. E. Hubb.	508
<i>Rhynchelytrum repens</i> (Willd.) C. E. Hubb.	415
<i>Rhynchelytrum villosum</i> (Parl.) Chiov.	582
<i>Setaria perennis</i> Hack.	448
<i>Setaria sphacelata</i> (Schumach.) Stapf & C. E. Hubb. ex M. B. Moss	522
<i>Setaria verticillata</i> (L.) Beauv.	564
<i>Setaria woodii</i> Hack.	439 O
<i>Cenchrus ciliaris</i> L.	514
<i>Aristida adsencionis</i> L.	
<i>Aristida bipartita</i> (Nees) Trin. & Rupr.	511
<i>Aristida congesta</i> Roem. & Schult. ssp. <i>barbicollis</i> (Trin. & Rupr.) de Winter	576
<i>Aristida congesta</i> Roem. & Schult. ssp. <i>congesta</i>	575
<i>Aristida diffusa</i> Trin. var. <i>burkei</i> (Stapf) Schweick.	572
<i>Aristida scabrivalvis</i> Hack.	
<i>Aristida stipitata</i> Hack. ex Schinz var. <i>graciliflora</i> (Pilg.) Melderis	577
<i>Sporobolus festivus</i> Hochst. ex A. Rich.	
<i>Sporobolus fimbriatus</i> Nees var. <i>fimbriatus</i>	
<i>Sporobolus fimbriatus</i> Nees var. <i>latifolia</i> Stent	503a
<i>Sporobolus nitens</i> Stent	440 C
<i>Sporobolus pyramidalis</i> Beauv.	579
<i>Sporobolus smutsii</i> Stent	437
<i>Sporobolus stapfianus</i> Gandoger	420
<i>Sporobolus virginicus</i> (L.) Kunth	
<i>Apochaete hispida</i> (L.f.) Phipps	
<i>Cynodon dactylon</i> (L.) Pers.	443
<i>Harpechloa falx</i> (L.) Kuntze	
<i>Enteropogon monostachyos</i> (Vahl) K. Schum. ssp. <i>africanus</i> W. D. Clayton	423
<i>Chloris gayana</i> Kunth	541
<i>Chloris pycnothrix</i> Trin.	539
<i>Chloris virgata</i> Sw.	513
<i>Eustachys paspaloides</i> (Vahl) Lanza & Mattei	466
<i>Tripogon abyssinicus</i> Nees	
<i>Tetrapogon mosambicensis</i> (K. Schum.) L. Chippindall ex B. S. Fisher	518
<i>Eleusine indica</i> (L.) Gaertn. f.	538
<i>Dactyloctenium australe</i> Steud.	509
<i>Dactyloctenium giganteum</i> Fischer & Schweick.	515
<i>Leptochloa panicea</i> (Retz.) Ohwi	563
<i>Enneapogon cenchroides</i> (Licht.) C. E. Hubb.	506
<i>Enneapogon scoparius</i> Stapf	465
<i>Fingerhuthia africana</i> Lehm.	544
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	
<i>Phragmites mauritanus</i> Kunth	651 R
<i>Diplachne eleusine</i> Nees	433
<i>Diplachne fusca</i> (L.) Beauv. ex Stapf	
<i>Pogonarthria squarrosa</i> (Licht.) Pilg.	504
<i>Trichoneura grandiglumis</i> (Nees) Ekman	419

<i>Eragrostis barbinodis</i> Hack.	507
<i>Eragrostis cilianensis</i> (All.) Lutati	547
<i>Eragrostis ciliaris</i> (L.) R. Br.	628
<i>Eragrostis curvula</i> (Schrud.) Nees	416
<i>Eragrostis gummiflua</i> Nees	549
<i>Eragrostis heteromera</i> Stapf	510
<i>Eragrostis superba</i> Peyr.	417

CYPERACEAE

<i>Cyperus articulatus</i> L.	629
<i>Cyperus difformis</i> L.	562
<i>Cyperus leptocladus</i> Kunth	436
<i>Cyperus margaritaceus</i> Vahl	435
<i>Cyperus fastigiatus</i> Rottb.	
<i>Cyperus obtusiflorus</i> Vahl	449
<i>Cyperus rupestris</i> Kunth	620
<i>Cyperus sexangularis</i> Nees	616
<i>Cyperus teneriffae</i> Poir.	421
<i>Cyperus textilis</i> Thunb.	
<i>Mariscus indecorus</i> (Kunth) Podlech	423
<i>Mariscus sieberianus</i> Nees	
<i>Mariscus vestitus</i> C.B. Cl.	619
<i>Kyllinga erecta</i> Schumach.	422
<i>Kyllinga melanosperma</i> Nees	
<i>Scirpus articulatus</i> L.	
<i>Scirpus cernuus</i> Vahl	
<i>Scirpus muricinix</i> C.B. Cl.	
<i>Scirpus paludicola</i> Kunth	
<i>Scirpus praelongatus</i> Poir.	
<i>Fimbristylis hispidula</i> (Vahl) Kunth	463
<i>Fimbristylis ovata</i> (Burm. f.) Kern	
<i>Bulbostylis boeckleriana</i> (Schweinf.) Beetle	424

PALMAE

<i>Phoenix reclinata</i> Jacq.	R
<i>Hyphaenae natalensis</i> Kuntze	R

COMMELINACEAE

<i>Commelina africana</i> L.	533
<i>Commelina benghalensis</i> L.	536
<i>Murdannia simplex</i> (Vahl) Brenan	617

JUNCACEAE

<i>Juncus lomatophyllus</i> Spreng.	R
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LILIACEAE

<i>Bulbine natalensis</i> Bak	
<i>Anthericum galpinii</i> Bak.	600
<i>Eriospermum burchellii</i> Bak.	

<i>Eriospermum galpinii</i> Schinz	
<i>Aloe marlothii</i> Berger	
<i>Aloe vanbalenii</i> Pillans	
<i>Gasteria</i> sp.	
<i>Albuca pachychlamys</i> Bak.	
<i>Dipcadi gracillima</i> Bak.	
<i>Scilla</i> sp.	604
<i>Ornithogalum ecklonii</i> Schlecht.	
<i>Asparagus falcatus</i> L.	
<i>Asparagus macowanii</i> Bak. var <i>zuluensis</i> (N.E. Br.) Jessop	
<i>Asparagus subulatus</i> Thunb.	
<i>Asparagus virgatus</i> Bak.	550

AMARYLLIDACEAE

<i>Haemanthus multiflorus</i> Mart.
<i>Ammocharis coranica</i> (Ker-Gawl.) Herb.
<i>Cyrtanthus galpinii</i> Bak.

IRIDACEAE

<i>Anomatheca laxa</i> (Thunb.) Goldblatt

MUSACEAE

<i>Strelitzia reginae</i> Banks ex Ait.

ORCHIDACEAE

<i>Ansellia gigantea</i> Reichb. f. var. <i>nilotica</i> Summerh.

SALICACEAE

<i>Salix woodii</i> Seemen	R
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ULMACEAE

<i>Chaetacme aristata</i> Planch.

MORACEAE

<i>Ficus capensis</i> Thunb.	
<i>Ficus capreifolia</i> Del.	
<i>Ficus pretoriae</i> Burt D. Davy	596
<i>Ficus soldanella</i> Warb.	
<i>Ficus sonderi</i> Miq.	589
<i>Ficus stuhlmannii</i> Warb.	487 O
<i>Ficus sycomorus</i> L.	595 R

URTICACEAE

<i>Urera tenax</i> N.E. Br.

LORANTHACEAE

Loranthus kraussianus Meisn.*Loranthus natalitus* Meisn.*Loranthus ngamicus* Sprague

SANTALACEAE

Thesium resedoides A.W. Hill

OLACACEAE

Ximenia caffra Sond. var. *natalensis* Sond.

POLYGONACEAE

Polygonum salicifolium Willd.

CHENOPODIACEAE

Chenopodium album L.

558

AMARANTHACEAE

Cyphocarpa angustifolia Lopr.*Cyathula spathulifolia* Lopr.*Achyroopsis leptostachya* Hook.f.*Alternanthera repens* (L.) O. Kuntze*Gomphrena celosioides* Mart.

529

601

NYCTAGINACEAE

Boerhavia diffusa L.

MOLLUGINACEAE

Hypertelis salsoloides (Burch.) Adamson

AIZOACEAE

Aizoon canariense L.*Aizoon glinoides* L.f.

543

MESEMBRYANTHEMACEAE

Aptenia cordifolia (L.f.) N.E. Br.*Delosperma pachyrhizum* L. Bol.

537

PORTULACACEAE

Portulacaria afra Jacq.*Portulaca kermesina* N.E. Br.*Portulaca quadrifida* L.

537b

610

CARYOPHYLLACEAE

Dianthus zeyheri Sond. ssp. *natalensis* Hooper O

CERATOPHYLLACEAE

Ceratophyllum demersum L.

MENISPERMACEAE

Cissampelos mucronata A. Rich.

CAPPARACEAE

Cleome diandra Burch.

Cleome monophylla L.

Capparis tomentosa Lam.

Boscia albitrunca (Burch.) Gilg & Ben.

Maerua angolensis DC.

Maerua rosmarinoides (Gand.) Gilg & Ben. 649

CRASSULACEAE

Crassula argentea Thunb.

Crassula transvaalensis Kuntze

LEGUMINOSAE

Acacia borleae Burtt Davy 481

Acacia brevispica ssp. *dregeana* (Benth.) Brenan 561

Acacia burkei Benth.

Most specimens in the Reserve are hybrids between *A. burkei* and *A. nigrescens* (Dr J. Ross, pers. comm.).

Acacia caffra (Thunb.) Willd. O

Acacia gerrardii Benth. var. *gerrardii* O

Acacia grandicornuta Gerstner C

Acacia karroo Hayne 451 O

Acacia luederitzii Engl. var. *retinens* (Sim) Ross & Brenan C

Acacia nigrescens Oliv. O

Acacia nilotica (L.) Willd. ex Del. ssp. *kraussiana* (Benth.) Brenan C

Acacia robusta Burch. ssp. *clavigera* (E. Mey.) Brenan R

Acacia senegal (L.) Willd. var. *rostrata* Brenan

Acacia sieberiana DC. var. *woodii* (Burtt Davy) Keay & Brenan 552

Very rare in the Reserve, known only from Makhamisa area.

Acacia tortilis (Forsk.) Hayne ssp. *heteracantha* (Burch.) Brenan O

Dichrostachys cinerea (L.) Wight & Arn.

Entada wahlbergii Harv. 597 R

Schotia brachypetala Sond.

Schotia capitata Bolle 479 C

Peltophorum africanum Sond.

Crotalaria monteiroi Taub. ex Bak.f.

Indigofera costata Guill. & Perr.

Indigofera sp. (= Tinley 850) 614

Mundulea sericea (Willd.) A. Chev.

Sesbania bispinosa (Jacq.) W. F. Wight

<i>Ormocarpum trichocarpum</i> (Taub.) Engl.	O
<i>Stylosanthes fruticosa</i> (Retz.) Alston	
<i>Glycine wightii</i> (R. Grah. ex Wight & Arn.) Verdc.	
<i>Erythrina lysistemon</i> Hutch.	592
<i>Rhynchosia nitens</i> Benth	
<i>Vigna decipiens</i> Harv.	605

OXALIDACEAE

Oxalis smithiana Eckl. & Zeyh.

ERYTHROXYLACEAE

Erythroxylum delagoense Schinz 587

ZYGOPHYLLACEAE

Tribulus terrestris L 534

BALANITACEAE

Balanites maughamii Sprague

RUTACEAE

Fagara capensis Thunb.

BURSERACEAE

Commiphora harveyi (Engl.) Engl. 458
Commiphora neglecta Verdoorn
Commiphora pyracanthoides Engl.
Commiphora schimperi (O. Berg.) Engl.

MELIACEAE

Turraea obtusifolia Hochst. 586
Trichilia emetica Vahl

MALPHIGIACEAE

Sphedamnocarpus galphimifolius (A. Juss.) Szyszyl.

POLYGALACEAE

Polygala serpentaria Eckl. & Zeyh. 599

EUPHORBIACEAE

Securinea virosa (Roxb. ex Willd.) Pax & K. Hoffm. 517
Phyllanthus maderaspatensis L. 603
Croton menyhartii Pax 477
Erythrococca natalensis Prain

<i>Acalypha glabrata</i> Thunb.	
<i>Acalypha indica</i> L.	557
<i>Tragia meyeriana</i> Muell. Arg.	
<i>Jatropha variifolia</i> Pax	
<i>Spirostachys africana</i> Sond.	C
<i>Euphorbia grandicornis</i> Goebel ex N.E. Br. ssp. <i>grandicornis</i>	C
<i>Euphorbia matabelensis</i> Pax	
<i>Euphorbia tirucalli</i> L.	

ANACARDIACEAE

<i>Sclerocarya caffra</i> Sond.	O
<i>Ozoroa engleri</i> R. & A. Fernandes	591 O
<i>Ozoroa obovata</i> (Oliv.) R. & A. Fernandes	460 O
<i>Ozoroa paniculosa</i> (Sond.) R. & A. Fernandes	640 O
<i>Rhus chirindensis</i> Bak.f. forma <i>legatii</i> (Schonl.) R. & A. Fernandes	584
<i>Rhus gueinzii</i> Sond. var. <i>spinescens</i> (Diels) R. & A. Fernandes	
<i>Rhus pentheri</i> Zahlbr.	461

CELASTRACEAE

<i>Maytenus heterophylla</i> (Eckl. & Zeyh.) N. Robson	478 R
<i>Maytenus senegalensis</i> (Lamb.) Exell	C
Some plants in Closed Woodland areas of the Reserve correspond with <i>M. cymosus</i> forma DE 1253 described by Edwards (1967).	
<i>Maytenus undata</i> (Thunb.) Blakelock	C
<i>Cassine aethiopica</i> Thunb.	474
<i>Cassine papillosa</i> (Hochst.) Kuntze	O
<i>Cassine transvaalensis</i> (Burt Davy) Codd	457 O

ICACINACEAE

Pyrenacantha grandiflora Baill.

SAPINDACEAE

Deinbollia oblongifolia (E. Mey.) Radlk.
Pappea capensis Eckl. & Zeyh.
Hippobromus pauciflorus (L.f.) Radlk.

RHAMNACEAE

Zizyphus mucronata Willd.
Berchemia zeyheri (Sond.) Grubov

HETEROPYXIDACEAE

Heteropyxis natalensis Harv.

VITACEAE

<i>Rhoicissus digitata</i> (L.f.) Gilg & Brandt	
<i>Rhoicissus tomentosa</i> (Lam.) Wild & Drummond	593
<i>Cissus quadrangularis</i> L.	
<i>Cissus rotundifolia</i> (Forsk.) Vahl	624
<i>Cyphostemma schlechteri</i> (Gilg & Brandt) Desc. ex Wild & Drummond	623

TILIACEAE

<i>Grewia bicolor</i> Juss.	473
<i>Grewia caffra</i> Meisn.	608
<i>Grewia flava</i> DC.	
<i>Grewia flavescens</i> Juss.	
<i>Grewia hexamita</i> Burret	
<i>Grewia monticola</i> Sond.	639
<i>Grewia occidentalis</i> L.	609
<i>Grewia</i> sp. cf. <i>kwebensis</i> N.E. Br.	
<i>Grewia subspathulata</i> N.E. Br.	
<i>Grewia villosa</i> Willd.	494

MALVACEAE

<i>Abutilon austro-africanum</i> Hochr.	
<i>Abutilon</i> sp.	535
<i>Hibiscus pusillus</i> Thunb.	632
<i>Thespesia acutiloba</i> (Bak.f.) Exell & Mendonca	456
<i>Cienfuegosia hildebrandtii</i> Garcke	631
<i>Gossypium herbaceum</i> L. var. <i>africanum</i> (Watt) Hutch. & Ghose	546

STERCULIACEAE

<i>Melhania polygama</i> Verdoorn	
<i>Melhania didyma</i> Eckl. & Zeyh.	
<i>Dombeya cymosa</i> Harv.	475
<i>Dombeya rotundifolia</i> (Hochst.) Planch.	
<i>Waltheria indica</i> L.	

OCHNACEAE

<i>Ochna natalitia</i> (Meisn.) Walp	545
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CLUSIACEAE

<i>Garcinia livingstonei</i> T. Anders.	503
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FLACOURTIACEAE

<i>Scolopia zeyheri</i> (Nees) Szyszyl.	
<i>Dovyalis caffra</i> (Hook.f. & Harv.) Hook.f.	

CACTACEAE

<i>Rhipsalis baccifera</i> (J. Mill.) Stearn	
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THYMELAEACEAE

<i>Lasiosiphon splendens</i> Endl.	622
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LYTHRACEAE

<i>Ammannia</i> sp.	
<i>Galpinia transvaalica</i> N.E. Br.	

COMBRETACEAE

<i>Combretum apiculatum</i> Sond.	486	O
<i>Combretum erythrophyllum</i> (Burch.) Sond.	484	O
<i>Combretum molle</i> R. Br. ex G. Don		O
<i>Terminalia phanerophlebia</i> Engl. & Diels	485	O

MYRTACEAE

<i>Syzygium guineense</i> (Willd.) DC.		R
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ONAGRACEAE

<i>Oenothera rosea</i> L'Hérit. ex Ait.		
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ARALIACEAE

<i>Cussonia zuluensis</i> Strey ined.	594	
<i>Cussonia spicata</i> Thunb.		

PRIMULACEAE

<i>Samolus valerandi</i> L.		
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PLUMBAGINACEAE

<i>Plumbago auriculata</i> Lam.		
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SAPOTACEAE

<i>Sideroxylon inerme</i> L.	472	C
<i>Mimusops obovata</i> Sond.	588	C
<i>Manilkara concolor</i> (Harv. ex C.H. Wr.) Gerstner		

EBENACEAE

<i>Euclea crispa</i> (Thunb.) Guerke var. <i>crispa</i>		
<i>Euclea divinorum</i> Hiern		C
<i>Euclea natalensis</i> A. DC.		C
<i>Euclea schimperi</i> (A. DC.) Dandy var. <i>daphnoides</i> (Hiern) De Winter		C
<i>Euclea undulata</i> Thunb. var. <i>undulata</i>	489	C
<i>Diospyros dichrophylla</i> (Gand.) De Winter	459	
<i>Diospyros glandulifera</i> De Winter	462	
<i>Diospyros lycioides</i> Desf. ssp. <i>sericea</i> (Bernh.) De Winter		
<i>Diospyros simii</i> (Knutze) De Winter		

OLEACEAE

<i>Olea africana</i> Mill.	493	C
<i>Jasminum multipartitum</i> Hochst.	590	

SALVADORACEAE

<i>Azima tetracantha</i> Lam.	554	R
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LOGANIACEAE

Strychnos madagascariensis Poir.*Strychnos spinosa* Lam.*Nuxia oppositifolia* (Hochst.) Benth.O
O
497

GENTIANACEAE

Chironia krebsii Griseb.

APOCYNACEAE

Rauvolfia caffra Sond.*Strophanthus gerrardii* Stapf*Wrightia natalensis* Stapf501 R
650

PERIPLOCACEAE

Stomatostemma monteiroae (Oliv.) N.E. Br.*Stomatostemma* sp.*Raphionacme elata* N.E. Br.

ASCLEPIADACEAE

Xysmalobium sp.*Ceropegia* sp.*Emplectanthus cordatus* N.E. Br.*Fockea tugelensis* N.E. Br.

CONVOLVULACEAE

Ipomoea plebeia R. Br. ssp. *africana* A. Meeuse

BORAGINACEAE

Cordia ovalis R. Br.*Ehretia rigida* (Thunb.) Druce*Heliotropium ciliatum* Kaplan*Heliotropium steudneri* Vatke*Heliotropium strigosum* Willd.*Trichodesma angustifolium* Bak.

483

531

VERBENACEAE

Chascanum hederaceum (Sond.) Moldenke var. *natalense* (H.H.W. Pearson)
Moldenke*Chascanum schlechteri* (Guerke) Moldenke

612

LABIATAE

Leucas glabrata (Vahl) R. Br. ex Benth.*Hyptis pectinata* (L.) Poir.*Coleus* sp.*Becium* sp.*Orthosiphon suffrutescens* (Thonning) J.K. Morton

555

532

SOLANACEAE

Lycium acutifolium E. Mey.

Lycium sp.

Solanum coccineum Jacq.

Solanum panduraeforme E. Mey.

607

SCROPHULARIACEAE

Veronica anagallis-aquatica Bernh.

Striga bilabiata (Thunb.) Kuntze ssp. *bilabiata*

Striga gesnerioides (Willd.) Vatke ex Engl.

SELAGINACEAE

Selago racemosa Bernh.

BIGNONIACEAE

Tecomaria capensis (Thunb.) Spach.

Kigelia africana (Lam.) Benth.

455

R

PEDALIACEAE

Ceratotheca triloba (Bernh.) Hook.f.

ACANTHACEAE

Thunbergia atriplicifolia E. Mey.

Thunbergia dregeana Nees

Chaetacanthus burchellii Nees

Ruellia patula Jacq.

Lepidagathis scabra C.B. Cl.

Barleria elegans S. Moore

Barleria obtusa Nees

Blepharis integrifolia (L.f.) E. Mey. ex Schinz

Crossandra fruticulosa Lindau

Crossandra greenstockii S. Moore

Asystasia sp.

Dictiptera clinopodia Nees

Ecbolium amplexicaule S. Moore

Justicia flava (Vahl) Vahl

Justicia petiolaris E. Mey. ex C.B. Cl.

598

606

636

530

635

527a

634

633

528

RUBIACEAE

Kohautia sp. probably *K. caespitosa* Schnizlein

Kohautia virgata (Willd.) Brem.

Xeromphis obovata (Hochst.) Keay

Xeromphis rudis (E. Mey. ex Harv.) Codd

Gardenia spatulifolia Stapf & Hutch.

Canthium setiflorum Hiern

Canthium spinosum (Klotzsch) Kuntze

Plectroniella armata (K.Schum.) Robyns

C

O

625

516

621

454 C

Dinocanthium hystrix Brem.

Pavetta delagoensis Brem.

Pavetta graciliflora Brem.

CURCUBITACEAE

Cucumis metuliferus E. Mey. ex Naud.

CAMPANULACEAE

Lobelia filiformis Lam. var. *natalensis* (A. DC.) E. Wimm.

COMPOSITAE

<i>Vernonia capensis</i> (Houtt.) Druce	630
<i>Vernonia fastigiata</i> Oliv. & Hiern	
<i>Ageratum conyzoides</i> L.	
<i>Felicia lutea</i> N.E. Br.	637
<i>Felicia muricata</i> (Thunb.) Nees	638
<i>Nidorella resedifolia</i> DC.	602
<i>Brachylaena ilicifolia</i> (Lam.) Phill. & Schweick.	
<i>Tarchonanthus camphoratus</i> L.	
<i>Tarchonanthus galpinii</i> Hutch. & Phill.	502
<i>Tarchonanthus trilobus</i> DC. var. <i>galpinii</i> (Hutch. & Phill.) J. Parva	
<i>Blumea cafra</i> (DC.) O. Hoffm.	
<i>Pluchea dioscoridis</i> (L.) DC.	453
<i>Sphaeranthus peduncularis</i> DC.	
<i>Gnaphalium luteo-album</i> L.	
<i>Helichrysum leptolepis</i> DC.	
<i>Helichrysum nudifolium</i> (L.) Less. var. <i>leiopodium</i> (DC.) Moeser	611
<i>Helichrysum rugulosum</i> Less.	412
<i>Pulicaria scabra</i> (Thunb.) Druce	
<i>Zinnia peruviana</i> (L.) L.	
<i>Flaveria bidentis</i> (L.) Kuntze	570
<i>Schkuhria pinnata</i> (Lam.) Cabrera	559
<i>Cotula anthemoides</i> L.	
<i>Senecio bupleuroides</i> DC.	
<i>Senecio madagascariensis</i> Poir.	
<i>Senecio</i> sp. aff. <i>barbertonicus</i> Klatt	
<i>Senecio viminalis</i> Brem.	
<i>Berkheya erysithales</i> (DC.) Roessler	